इंटरनेट मानक

Disclosure to Promote the Right To Information

Whereas the Parliament of India has set out to provide a practical regime of right to information for citizens to secure access to information under the control of public authorities, in order to promote transparency and accountability in the working of every public authority, and whereas the attached publication of the Bureau of Indian Standards is of particular interest to the public, particularly disadvantaged communities and those engaged in the pursuit of education and knowledge, the attached public safety standard is made available to promote the timely dissemination of this information in an accurate manner to the public.

“जानने का अधिकार, जीने का अधिकार”
Mazdoor Kisan Shakti Sangathan
“The Right to Information, The Right to Live”

“पुराने को छोड नये के तरफ”
Jawaharlal Nehru
“Step Out From the Old to the New”

IS/QC 160000-1 (1988): Electrical Relays, Part 1: Test and Measurement Procedures for Electromechanical All-or-Nothing Relays [ETD 35: Power Systems Relays]

“ज्ञान से एक नये भारत का निर्माण”
Satyanarayan Gangaram Pitroda
“Invent a New India Using Knowledge”

Act Number 22 of 2005
The Indian Parliament
RIGHT TO INFORMATION

Made Available By
Public.Resource.Org

“ज्ञान एक ऐसा खजाना है जो कभी चुराया नहीं जा सकता है”
Bhartṛhari—Nītiśatakam
“Knowledge is such a treasure which cannot be stolen”

BLANK PAGE

BRUTUM FULMEN

IGNORANTIA JURIS NON EXCUSAT

PROTECTED BY COPYRIGHT

IS QC 160000 (Part 1) : 1988
IEC Pub 255-7 (1978)

(Reaffirmed 1999)

Indian Standard

SPECIFICATION FOR ELECTRICAL RELAYS

Part 1 Test and Measurement Procedures for Electromechanical All-or-Nothing Relays

UDC 621.318.56 : 621.317.3

© BIS 1990

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

January 1990

Price Rs 140.00

Indian Standard

SPECIFICATION FOR ELECTRICAL RELAYS

Part 1 Test and Measurement Procedures for Electromechanical All-or-Nothing Relays

National Foreword

This Indian Standard (Part 1), which is identical with IEC Pub 255-7 (1978) 'Electrical relays,Part 7 Test and measurement procedures for electromechanical all-or-nothing relays' issued by the International Electrotechnical Commission (IEC), was adopted by the Bureau of Indian Standards on 7 September 1988 on the recommendation of the Relays Sectional Committee (ETDC 35) and approval of the Electrotechnical Division Council.

This standard is intended primarily for use under the IECQ system. A regular Indian Standard for this component could be different, identical or similar to this standard.

The text of IEC standard has been approved as suitable for publication as Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

Wherever the words 'International Standard' appear, referring to this standard, they should be read as 'Indian Standard'.

Cross References

The technical committee responsible for the preparation of this standard has reviewed the provisions of the following IEC Publications and has decided that they are acceptable for use in conjunction with this standard:

IEC Pub 50 International electrotechnical vocabulary

IEC Pub 60 High voltage test techniques

IEC Pub 68 Basic environmental testing procedures

IEC Pub 68-1-1982 Part 1 General

IEC Pub 68-2 Part 2 Tests

IEC Pub 68-2-1-1974 Test A Cold

IEC Pub 68-2-2-1974 Test B Dry heat

IEC Pub 68-2-3-1969 Test Ca : Damp heat steady state

IEC Pub 68-2-4-1960 Test D : Accelerated damp heat

IEC Pub 68-2-6-1982 Test Fc : Vibration (sinusoidal)

IEC Pub 68-2-7-1983 Test Ga : Acceleration and guidance, steady state

IEC Pub 68-2-10-1984 Test J : Mould growth

IEC Pub 68-2-11-1981 Test Ka : Salt mist

IEC Pub 68-2-13-1983 Test M : Low air pressure

IEC Pub 68-2-14-1984 Test N : Change of temperature

IEC Pub 68-2-17-1978 Test Q : Sealing

IEC Pub 68-2-20-1979 Test T : Soldering

IEC Pub 68-2-21-1983 Test U : Robustness of termination and integral mounting devices

IEC Pub 68-2-27-1987 Test Ea : Part 2 Tests and guidance shock

IEC Pub 68-2-28-1980 Guidance for damp heat tests

IEC Pub 144-1963 Degrees of protection of enclosures for low-voltage switchgear and controlgear

IEC Pub 147-5-1977 Essential ratings and characteristics of semi conductor devices and general principles of measuring methods : Part 5 Mechanical and climatic test methods

IEC Pub 255-0-20-1974 Electrical relays :Contact performance of electrical relays

IEC Pub 255-1-00-1975 All-or-nothing relays

IEC Pub 255-5-1977 Insulation tests for electrical relays

IEC Pub 443-1974 Stabilized supply apparatus for measurement

Only the English language text given in the IEC Publication has been retained while adopting it as Indian Standard.

CONTENTS

Clause Page

1. Scope 5
2. Object 5

SECTION ONE—TERMINOLOGY

3. Types of relays 5
4. Functions of a relay 6
5. Types of contacts 7
6. Prefixes for the values applicable to relays 7
7. Energization values 7
8. Electrical properties of contacts 9
9. Application categories of contacts 9
10. Mechanical properties of contacts 10
11. Terms relating to times 10

SECTION TWO—TEST AND MEASUREMENT PROCEDURES

12. General 11
13. Alternative methods 11
14. Precision of measurement 11
15. Requirements in detail specifications 11
16. Standard conditions for testing 12
17. Visual inspection and check of dimensions 13
18. Mechanical tests and weighing 13
19. Coil resistance, inductance, impedance and burden 14
20. Dielectric test 15
21. Impulse voltage test 16
22. Insulation resistance 16
23. Contact-circuit resistance (or voltage drop) 17
24. Functional tests 18
25. Timing tests 19
26. Climatic sequence 20
27. Damp heat, steady state 23
28. Thermal resistance 23
29. Temperature rise 24
30. Rapid change of temperature 25
31. Enclosure 26
32. Internal moisture 26
33. Corrosive atmospheres 27
34. Mould growth 27
35. Robustness of terminals 28
36. Soldering 28
37. Shock 29
38. Bump 29
39. Vibration 30
40. Acceleration 31
41. Electrical endurance 32
42. Mechanical endurance 35
43. Thermal endurance 36
44. Limiting continuous current 37
45. Overload (contact circuits) 37
46. Load transfer 38
47. Electromagnetic compatibility 39
48. Magnetic interference 39
49. Crosstalk and insertion loss 39
50. Electrical contact noise 40
51. Thermoelectric e.m.f. 40
52. Capacitances 40
53. Contact sticking 41
54. Magnetic remanence 41
55. Acoustic noise 42
56. Continuity of protective earth connection 42
57. Fluid contamination 42
58. Resistance to solvents 43
FIGURES 1 to 9 44

As in the Original Standard, this Page is Intentionally Left Blank

1. Scope

This standard states the test and measurement procedures for electromechanical all-or-nothing relays within the scope of the IEC. It covers basic considerations which are, in general, common to all types of relays covered by IEC Publication 255, Electrical Relays, and is of particular interest for all-or-nothing relays of assessed quality. Supplementary requirements may be necessitated by specific designs or application.

This standard will be extended by other tests intended more specifically for electromechanical all-or-nothing relays, with specified time.

2. Object

The object of this standard is to state, for electromechanical all-or-nothing relays:

— special terms and definitions used (Section One) and

— test and measurement procedures (Section Two).

SECTION ONE — TERMINOLOGY

For the purpose of this standard, the following terms and definitions apply:

Note. — For the definitions of general terms used in this standard, reference should be made to Chapter 446: Electrical relays, of the International Electrotechnical Vocabulary. (See IEC Publication 50(446).)

However, in order to cover both monostable and bistable relays, amendments have been added to those definitions.

3. Types of relays

3.1 *Electromechanical relay (I.E.V. 446-01-08)*

An electrical relay, in which the designed response is developed by the relative movement of mechanical elements under the action of a current in the input circuit(s).

3.2 *All-or-nothing relay (I.E.V. 446-01-02 modified)*

An electrical relay which is intended to be energized by a quantity whose value is either:

— higher than that at which it operates,

— or lower than that at which it releases.

Note. — The adjective "all-or-nothing" can be deleted when no ambiguity may occur.

3.3 *Monostable relay (I.E.V. 446-01-12)*

An electrical relay which, having responded to an input energizing quantity (or characteristic quantity) and having changed its condition, returns to its previous condition when the quantity is removed.

3.4 *Bistable relay (I.E.V. 446-01-13)*

An electrical relay which, having responded to an input energizing quantity (or characteristic quantity) and having changed its condition, remains in that condition after the quantity has been removed. Another appropriate further energization is required to make it change over.

3.5 *Polarized relay*

A relay the change of condition of which depends upon the direction of its input energizing quantity(ies).

3.6 *Non-polarized relay*

A relay the change of condition of which does not depend upon the direction of its input energizing quantity(ies).

4. Functions of a relay

4.1 *Release condition (I.E.V. 446-03-01 modified)*

For a monostable relay, the specified condition of the relay when it is not energized. For a bistable relay, the conventional condition as declared by the manufacturer.

4.2 *Operate condition (I.E.V. 446-03-02 modified)*

For a monostable relay, the specified condition of the relay when it is appropriately energized

For a bistable relay, the alternate condition to the release condition as declared by the manufacturer.

4.3 *To operate*

A relay operates when it changes from its release condition to its operate condition.

Note. — The term "to operate" is used for both "to pick up" (I.E.V. 446-03-03) and "to operate" (I.E.V. 446-03-17) of Chapter 446.

This term is applicable to both monostable and bistable relays.

4.4 *To release*

A relay releases when it changes from its operate condition to its release condition.

Note. — The term "to release" is used for both "drop out" (I.E.V. 446-03-04) and "return" (446-03-18) of Chapter 446.

This term is applicable to both monostable and bistable relays.

4.5 *To change over (I.E.V. 446-03-05 modified)*

A relay changes over when it operates or releases.

4.6 *To cycle (I.E.V. 446-03-06 modified)*

A relay cycles when it operates and then releases, or vice-versa.

4.7 *To revert*

For a particular polarized or bistable relay being in an operate condition, to change from this condition to the release condition by increasing the value of the energizing quantity.

4.8 *To revert reverse*

For a particular bistable relay being in a release condition by an appropriate energization, to change from this condition to the operate condition by increasing the value of this energizing quantity.

5. Types of contacts

5.1 *Make contact (I.E.V. 446-06-15 modified)*

A contact which is closed when the relay is in its operate condition and which is open when the relay is in its release condition.

5.2 *Break contact (I.E.V. 446-06-16 modified)*

A contact which is open when the relay is in its operate condition and which is closed when the relay is in its release condition.

6. Prefixes for the values applicable to relays

Values may be defined as rated, actual ("just"), test ("must") or characteristic value and identified as such by using one of these words as a prefix. The prefixes are also applicable to timing values.

6.1 *Rated value (I.E.V. 151-04-03)*

Value of a quantity assigned, generally by a manufacturer, for a specified operating condition of a relay.

6.2 *Actual ("just") value*

Value of a quantity measured on a single relay when it just performs a specified function.

6.3 *Test ("must") value*

Value of a quantity at which, during tests, the relay is required to perform or not to perform a specified function.

6.4 *Characteristic value*

Value of a quantity at which, throughout its lifetime or a specified number of cycles, the relay is required to comply with a specified requirement.

7. Energization values

7.1 *Energizing quantity (I.E.V. 446-02-01)*

An electrical quantity (either current or voltage) which alone, or in combination with other such quantities, applied to a relay under specified conditions enables it to fulfil its purpose.

7.2 *Rated value of an energizing quantity*

Value of an energizing quantity to which some of the specified characteristics are referred.

7.3 *Actual ("just") value of an energizing quantity*

Value of an energizing quantity measured on a single relay, when it just performs a specified function.

7.4 *Test ("must") value of an energizing quantity*

Value of an energizing quantity at which, during tests, the relay is required to perform or not to perform a specified function.

7.5 *Characteristic value of an energizing quantity*

Value of an energizing quantity at which, throughout its lifetime or a specified number of cycles, the relay is required to comply with a specified requirement.

7.6 *Operative range of an energizing quantity (I.E.V. 446-02-11)*

The range of values of an energizing quantity for which the relay under specified conditions is able to perform its intended function(s) according to the specified requirements.

7.7 *Magnetic preconditioning value*

For this term and for the following terms refer also to Figures 1 to 5, pages 44 to 46, which show the sequential functions of relays covered by the definitions.

Value of the energizing quantity at which the relay attains a defined magnetic condition.

Notes 1. — For polarized relays, distinction is made between preconditioning in forward (operate) direction, and preconditioning in reverse direction.

2. — For bistable relays, preconditioning may also be used to set the relay to a defined position.

7.8 *Non-operate value*

Value of the energizing quantity at which a relay does not operate.

7.9 *Operate value*

Value of the energizing quantity at which a relay operates.

7.10 *Non-release value*

Value of the energizing quantity at which a relay does not release.

7.11 *Release value*

Value of the energizing quantity at which a relay releases.

7.12 *Non-revert value*

Value of the energizing quantity exceeding the operate value at which a particular polarized or bistable relay does not revert.

7.13 *Reverse non-revert value*

Value of the energizing quantity exceeding the release value at which a particular bistable relay does not revert reverse.

7.14 *Reverse polarity value*

Value of the energizing quantity of reverse polarity at which a polarized monostable relay does not operate.

8. Electrical properties of contacts

8.1 *Contact current*

The current which a relay contact carries before opening or after closing.

8.2 *Contact voltage*

The voltage between the contact members before closing or after opening.

8.3 *Limiting continuous current (I.E.V. 446-06-17 modified)*

The highest value of the current (r.m.s. if a.c.), which a previously closed contact circuit is capable of carrying continuously.

8.4 *Contact noise*

The spurious voltage which appears across the terminations of a closed contact.

9. Application categories of contacts

9.1 *Category 0 contact*

A contact characterized by a maximum contact voltage of 30 mV, and a maximum contact current of 10 mA.

9.2 *Category 1 contact*

A contact characterized by a contact voltage between 30 mV and 60 V, and a contact current between 10 mA and 0.1 A.

9.3 *Category 2 contact*

A contact characterized by a contact voltage between 5 V and 250 V, and a contact current between 0.1 A and 1 A.

9.4 *Category 3 contact*

A contact characterized by a contact voltage between 5 V and 600 V, and a contact current between 0.1 A and 100 A.

Note. — A contact may have the characteristics of more than one category.

10. Mechanical properties of contacts

10.1 *Contact gap (I.E.V. 446-06-06)*

The gap between the contact tips (points) under specified conditions when the contact circuit is open.

10.2 *Contact force (I.E.V. 446-06-07)*

The force which two contact tips (points) exert against each other in the closed position under specified conditions.

11. Terms relating to times

The operate time, release time, transfer time and bridging time, as defined hereunder, do not include bounce times.

The operate time covers the closing time of a make contact and the opening time of a break contact.

The release time covers the opening time of a make contact and the closing time of a break contact.

11.1 *Operate time*

For a relay which is in the release condition (initial condition) the time interval between the instant a specified value of the input energizing quantity (characteristic quantity) is applied under specified conditions and the instant when the output make circuit closes or the output break circuit opens.

Note. — This term is used only when the relay has only one output circuit or when it has several similar output circuits and no precision is required as to contact time difference.

11.2 *Release time*

For a relay which is in the operate condition (final condition) the time interval between the instant a specified value of the input energizing quantity (characteristic quantity) is applied under specified conditions and the instant when the output make circuit opens or the output break circuit closes.

Note. — This term is used only when the relay has only one output circuit or when it has several similar output circuits and no precision is required as to contact time difference.

11.3 *Transfer time*

For a break-before-make change over contact, the time interval during which both contact circuits are open.

11.4 *Bridging time*

For a make-before-break change over contact, the time interval during which both contact circuits are closed.

11.5 *Bounce time (I.E.V. 446-07-06)*

For a contact which is closing (opening) its circuit, the time interval between the instant when the contact circuit first closes (opens) and the instant when the circuit is finally closed (opened).

11.6 *Time to stable closed condition*

The time interval between the instant when a specified value of the energizing quantity is applied and the instant when a contact circuit fulfils specified requirements.

11.7 *Minimum time of operate energization*

Minimum duration of application of rated operate value required to ensure that the contact circuit fulfils specified requirements.

11.8 *Contact time difference*

For a relay having several contacts of the same type, the difference between the maximum value of the operate (release) time of the slowest and the minimum value of the operate (release) time of the fastest.

SECTION TWO — TEST AND MEASUREMENT PROCEDURES

12. General

The sectional or blank detail specifications shall contain tables showing the tests to be made, which measurements are to be made before and after each test or sub-group of tests, and the sequence in which they shall be carried out.

13. Alternative methods

Measurements shall preferably be carried out by using the methods specified. Any other method giving equivalent results may be used except in case of dispute.

Note. — By "equivalent" is meant that the value of the characteristic established by such other method will fall within the specified limits when measured by the specified method.

14. Precision of measurement

The limits quoted in detail specifications are true values. Measurement inaccuracies shall be taken into account when evaluating the results. Usual precautions should be taken to reduce measurement errors to a minimum.

15. Requirements in detail specifications

If the technical requirements of the generic specification relative to inspection are not entirely suitable (either for technical reasons or because of a special application) to the relay described in the detail specification, the latter will set out clearly the various amendments which are to be made to these requirements.

16. Standard conditions for testing

16.1 Unless otherwise specified, all tests shall be carried out under the standard atmospheric conditions for testing as specified in Sub-clause 5.3 of IEC Publication 68.1, Basic Environmental Testing Procedure, Part I: General, i.e.:

Temperature	15 °C ... 35 °C
Relative humidity	45% ... 75%
Air pressure	86 kPa ... 106 kPa (860 mbar ... 1060 mbar)

In case of dispute, the referee conditions are:

Temperature	27 °C ± 1 °C
Relative humidity	63% ... 67%
Air pressure	86 kPa ... 106 kPa (860 mbar ... 1060 mbar)

(See Sub-clause 5.2 of IEC Publication 68-1.)

The relays shall be under standard atmospheric conditions for testing for a time sufficient to allow them to reach thermal equilibrium.

16.2 Unless otherwise specified, the terms a.c. voltage and current indicate r.m.s. values throughout this standard.

16.3 Any value to be assigned to quantities as defined in this standard will relate to specified conditions which are within the intended conditions of use of a relay, and different values may apply to steady-state and dynamic operation.

16.4 Unless otherwise specified, the following shall apply to power supplies and their connections. (See IEC Publication 443, Stabilized Supply Apparatus for Measurement.)

16.4.1 The operating error in voltage or current shall not exceed 5% for a load twice that specified for the test.

The peak-to-peak periodic and random deviations of a d.c. supply shall not exceed 1%.

The operating error in frequency of an a.c. supply shall not exceed 1%, and the form factor shall be within 0.95 to 1.25.

16.4.2 The following shall be earthed as applicable: the negative side of the d.c. power supply, one side of the single-phase a.c. power supply, or the neutral of the three-phase a.c. power supply.

16.4.3 The earthed side of the power supply shall be connected to: one terminal of the coil, or one terminal each of one or more coils of the relay under test, and one terminal of each of the loads connected to the relay under test.

16.5 Contacts and/or other parts shall not be cleaned or adjusted prior to submission to a test, unless otherwise prescribed in the detail specification.

16.6 Where mounting is required for a particular test, the relay shall be mounted in accordance with the specified fixing instructions.

16.7 Conditions prescribed in the detail specification:

1) Atmospheric conditions, if other than in Sub-clause 16.1.
2) Properties of the power supply, and its connections, if other than in Sub-Clause 16.4.
3) Cleaning and/or adjustment prior to testing, if required.
4) Fixing instructions.
5) Tests to which these conditions are to be applied, unless applicable to all tests.
6) Steady-state or dynamic operation.

17. Visual inspection and check of dimensions

17.1 The relays shall be checked for conformity to the outline drawings, including creepage distances and clearances, prescribed in the detail specification.

17.2 Unless otherwise prescribed in the detail specification, visual inspection shall be performed under normal factory lighting and visual conditions.

17.3 External inspection and check of key dimensions shall be carried out as non-destructive tests.

17.4 Visual inspection shall include:

1) Correctness of marking.
2) Correctness of terminal identification.
3) Correct housing.
4) Absence of physical defects, as prescribed in the detail specification.

17.5 The condition, workmanship and finish shall be satisfactory as determined by visual inspection.

17.6 Shaking of the relay shall be carried out as an audible inspection to detect loose particles, if prescribed in the detail specification.

17.7 Conditions prescribed in the detail specification:

1) Dimensions and tolerances, marking and terminals to be checked, if required.
2) Creepage distances and clearances to be checked, and their minimum values.
3) Particular lighting and/or optical devices, if required.
4) Shaking of the relay, if required.
5) Physical properties to be checked, and required results.

18. Mechanical tests and weighing

18.1 Mechanical test procedures, if required (e.g. contact force, armature travel) shall be as prescribed in the detail specification.

18.2 Where prescribed in the detail specification, the relay shall be weighed.

18.3 Conditions prescribed in the detail specification:

1) Mechanical properties to be tested, methods of tests, and required results.
2) Mass of the relay, and tolerances.

19. Coil resistance, inductance, impedance and burden

19.1 *Coil resistance*

19.1.1 Purpose: to ensure that the d.c. resistance of the relay coil(s) is within specified limits.

19.1.2 Procedure: the resistance shall be measured between the terminals of the relay. The method shall involve negligible temperature rise. The reference temperature shall be 20 °C unless otherwise prescribed in the detail specification.

19.1.3 Conditions prescribed in the detail specification:

1) Coil resistance limits.
2) Reference temperature, if other than 20 °C.
3) Temperature coefficient of the wire material, if other than electrolytic copper.

4) Any special precautions due to the presence of resistors, diodes, etc. in the coil circuit.

19.2 *Coil inductance*

19.2.1 Purpose: to ensure that the inductance of the relay coil(s) is within the specified limits.

19.2.2 Procedure: the coil inductance shall be measured in the non-energized and in the rated energized condition of the relay. The relay shall be mounted with no adjacent metal parts.

Unless otherwise prescribed in the detail specification, the a.c. voltage applied for measurement shall be sinusoidal at a frequency equal to the nominal frequency of the energizing quantity or for d.c. relays as prescribed in the detail specification.

The measurement of inductance, by determining the time constant, is a permissible alternative.

When d.c. energization is to be superimposed in the winding during measurement, adequate means for isolation of the a.c. and d.c. circuits shall be provided

19.2.3 Conditions prescribed in the detail specification:

1) Coil inductance limits.
2) Voltage of the applied a.c. supply.
3) Frequency of the applied a.c. supply.
4) Rated energization value.
5) Any alternative procedure, if the above is not applicable.

19.3 *Coil impedance and burden*

19.3.1 Purpose: to ensure that the impedance of the relay coil(s) is within specified limits.

19.3.2 Procedure: the relay shall be mounted with no adjacent metal parts.

Method 1: the coil impedance shall be measured in the non-energized and the rated energized condition of the relay. Unless otherwise prescribed in the detail specification, the a.c. voltage applied for measurement shall be sinusoidal at a frequency equal to the nominal frequency of the energizing quantity or, for d.c. relays, as prescribed in the detail specification.

When d.c. energization is to be superimposed in the winding during measurement, adequate means for isolation of the a.c. and d.c. circuits shall be provided.

Method 2: the burden shall be measured in the rated energized condition of the relay or, for a relay the burden of which varies with the position of its moving parts, in the energized conditions as prescribed in the detail specification.

19.3.3 Conditions prescribed in the detail specification:

1) Method 1 or 2.
2) Coil impedance or burden limits.
3) Rated energization value or, with method 2, the energization test values.
4) Method 1: voltage of the applied a.c. supply and its frequency.
5) An alternative procedure, if the above is not applicable.

20. **Dielectric test**

20.1 Procedure: this test shall be carried out in accordance with the dielectric test in Clause 6 of IEC Publication 255-5 (1977), Part 5: Insulation Tests for Electrical Relays, except that the terminals to which the test voltage is applied shall be those prescribed in the detail specification.

20.2 Conditions prescribed in the detail specification:

1) terminals to which the test voltage shall be applied, selected from the following:
    a) terminals of each contact circuit:
    — break contacts shall be opened for this test;
    b) all terminals requiring the same test voltage connected together and any exposed conductive part not intended to be electrically connected, the latter being simulated by a foil wrapped around relays having an insulating enclosure (in this case this test is only a type test) (see IEC Publication 255-5, Sub-clause 5.3);
    c) terminals of separate windings (bifilar or not);
    d) all coil terminals requiring the same test voltage connected together and all contact circuit terminals connected together;
    e) terminals of separate contact circuits.
2) Test voltage or voltages, or the rated insulation voltage(s) and the series in accordance with Table I of IEC Publication 255-5.

3) Duration of the test: 1 s or 1 min.

4) Maximum leakage current, if applicable.

5) Reductions for repetition tests, e.g. for final measurement after an endurance test. These shall be specified together with such tests.

21. Impulse voltage test

21.1 Procedure: this test shall be carried out in accordance with the impulse voltage test in Clause 8 of IEC Publication 255-5, and shall be applied to the parts of the relay and following the detailed requirements specified in the detail specification. A flashover is a criterion of failure only if it causes permanent damage; after application of the impulses, the relay shall comply with the final measurements prescribed in the detail specification.

21.2 Conditions prescribed in the detail specification:

1) Number of impulses, if other than three positive and three negative impulses.
2) Terminals to which the test voltage is applied.
3) Waveform and generator characteristics, if other than a standard lightning impulse in accordance with IEC Publication 60: High-voltage Test Techniques, and/or deviating from the standard test circuit recommended in IEC Publication 255-5.
4) Value of the impulse voltage.
5) Required test results and final measurements to verify compliance.

22. Insulation resistance

22.1 Procedure: this test shall be carried out in accordance with the insulation resistance measurement procedure in Clause 7 of IEC Publication 255-5, except that the terminals concerned, and the time to steady-state reading, if required, shall be those prescribed in the detail specification, and that the measurement voltage shall be 500 V unless otherwise prescribed in the detail specification.

22.2 Conditions prescribed in the detail specification:

1) Terminals to which the test voltage shall be applied, selected from the following:
   a) terminals of each contact circuit. Break contacts shall be opened for this test;
   b) all terminals requiring the same test voltage connected together and any exposed conductive part not intended to be electrically connected, the latter being simulated by a foil wrapped around relays having an insulating enclosure (in this case this test is only a type test) (see IEC Publication 255-5, Sub-clause 5.3);
   c) terminals of separate windings (bifilar or not);
   d) all coil terminals requiring the same test voltage connected together and all contact circuit terminals connected together;
   e) terminals of separate contact circuits.
2) Measurement voltage, if other than 500 V.
3) Time to steady-state reading, if required.
4) Minimum value(s) of insulation resistance(s).

23. Contact-circuit resistance (or voltage drop)

23.1 Procedure: the resistance shall be measured using a four-terminal bridge, by the voltmeter-ammeter method, or, particularly for dynamic tests, using an automatic monitoring equipment. Measurements shall be made with alternating voltage at a frequency between 0.8 kHz and 2 kHz, or as prescribed in the detail specification. If d.c. is prescribed, the resistance shall be measured for both polarities.

One measurement shall be made per cycle.

The type of measurement shall be as prescribed in the detail specification, and be selected from the following:

a) Static contact resistance measurement denotes that, for each measurement, the contacts remain closed for an interval sufficient to allow all transients to decay. Three test cycles shall be made.

b) Dynamic contact resistance measurement denotes that the relay coil is energized by a square wave, the frequency being as prescribed in the detail specification. A specified number of cycles shall be made, and each of the cycles shall be monitored. Monitoring shall start after the contact has reached stable closed condition, or after at least 30% of the closed part of each duty cycle has elapsed, whichever is later.

The coil shall be energized at the rated energization, or as specified in the detail specification if necessary.

There shall be no conditioning cycle prior to the measurement.

The voltage shall be applied after the contacts are closed, and removed before the contacts are opened.

If a relay contact belongs to more than one category, the test shall be based on the requirements for the lowest category.

Note. — During the endurance test, checking of contact resistance can be carried out by another method, for example by checking the voltage drop across the tested contact with the load current flowing through the contact.

23.2 Conditions prescribed in the detail specification:

1) Frequency of the test voltage, if other than 0.8 kHz to 2 kHz.
2) Type of measurement: steady-state or dynamic operation.
3) For dynamic tests, the frequency of the square wave, the number of cycles, and the gated measurement time.
4) Energization value, if other than rated value.
5) Points of measurement.
6) Test contact current, which shall be selected from the following:
   a) application category 0: 10 mA;
   b) application category 1: 10 mA;
   c) application category 2: 100 mA;
   d) application category 3: 1 A.

7) Test contact voltage, which shall be selected as appropriate from the following:

   a) application category 0: 30 mV max.;
   b) application category 1: 100 mV;
   c) application categories 2 + 3: 24 V.

   For 1, 2 and 3, contacts may be tested at the declared minimum rated voltage.

8) Maximum contact resistance.

24. Functional tests

24.1 Purpose: to ensure that the relay performs satisfactorily at its specified energization values.

24.2 Procedure: Table I sets out the applicable values and the significance of the functional tests, referring to Figures 1 to 5, pages 44 to 46, which give typical examples.

Testing is made by attributes, and shall be made in the order given below, or in the order prescribed in the detail specification.

Testing by variables: no requirements at present.

When required by the detail specification, the magnetic conditioning shall be applied, and the orientation of the relay shall take account of the external magnetic field.

When proceeding from one step to the next, the characteristics of the energizing quantity shall be as prescribed in the detail specification. The corresponding function of the relay shall be checked by visual inspection or, if this is impracticable, by monitoring the contacts.

24.3 Conditions prescribed in the detail specification:

1) Energization values and values for conditioning, as required, and their polarity.
2) Order of steps, if different from above.
3) Application of subsequent pulses, instead of stepwise changes, if applicable.
4) Time between the steps, or device to be used to perform them, if a more precise specification is required.
5) Application of the test to new relays or after a specified number of cycles.
6) Magnetic orientation, if required.
7) Details of monitoring, if required.

TABLE I

Energization values and corresponding functions

Diagram code	Applied value	The relay shall	Applicable to
a	Non-operate value	Not operate	All types
b	Operate value	Operate	All types
c	Rated value	Remain operated	All types
d	Non-revert value	Remain operated	Polarized or bistable
e/*g*	Non-release value	Not release	All types
f/*h*	Release value	Release	All types
i	Reverse rated value	Remain non-operated	Bistable polarized
j	Reverse non-revert value	Not operate	Bistable
k	Reverse polarity value	Not operate	Monostable polarized
x	Conditioning value	Be conditioned	All if required
y	Setting value	Be set in required position	All if required
z	Reverse setting value	Be set in required position	All if required

25. **Timing tests**

25.1 Purpose: to ensure that the times are within the specified limits.

25.2 Procedure: for the energization of the coil, the output impedance of the source shall be chosen to ensure that the maximum voltage drop and the settling time do not exceed the values prescribed in the detail specification.

For application category 0 and 1, the contact voltage shall be 10 ... 30 mV unless otherwise prescribed in the detail specification.

For application categories 2 and 3, the contact voltage shall be as prescribed in the detail specification.

The contact current shall be 10 mA, unless otherwise prescribed in the detail specification.

The switch for switching the coil shall be bounce-free.

For a.c. relays a synchronous switching device, variable in point on wave, shall be used. According to the detail specification the phase shall be set either to obtain the maximum time interval or to the specified points on wave.

For the measurement of operate time, transfer time, bridging time, release time and bounce time, a suitable circuit is given in Figure 6, page 47, and typical traces on the oscilloscope screen are shown in Figure 7, page 48. The time coefficient shall be such that the display covers the whole screen.

25.2.1 Operate time. Operate time, transfer time and bridging time shall be measured by a suitable method when the relay is energized as prescribed in the detail specification.

25.2.2 Release time. Release time, transfer time and bridging time shall be measured by a suitable method after the disconnection of the specified energization.

25.2.3 Bounce time. Contact bounce time shall be measured using a suitable test circuit such as that shown in Figure 6.

The test shall be made on at least one specified contact unit, using a resistive load.

Discontinuities of less than 10 μs, unless otherwise prescribed in the detail specification, shall be ignored.

25.2.4 Time to stable closed condition. The test shall be made on at least one specified contact circuit by applying specified energization values and measuring specified contact parameters after the specified time to stable closed conditions, all details being as prescribed in the detail specification, if this test is required.

25.2.5 Minimum time of operate energization. The test shall be made on at least one specified contact circuit. The relay shall be energized with its rated energization value and, after elapse of the specified minimum time of operate energization, the energization shall be reduced to:

a) zero, for bistable relays;

b) the specified characteristic non-release value, for monostable relays.

After the reduction, the specified contact parameters shall be measured, all details being as prescribed in the detail specification, if this test is required.

25.2.6 Contact time difference. The test shall be made on two or more specified contact circuits, each of them being monitored by one trace of a multitrace oscilloscope using a suitable method similar to that given by Figures 6 and 7, pages 47 and 48. The traces shall be expanded as required to observe the differences in events.

25.3 Conditions prescribed in the detail specification:

1) Mounting or position of the relay.
2) Energization value, number of cycles per hour and duty factor of the energization. Preferably, the lower limit of the operative range should be used for testing the operate time, and the upper limit for testing the release time.

3) Means for the disconnection for release time measurement, if of importance. Short-circuiting the relay coil while protecting the power supply source from overload may be specified, as an alternative.
4) Maximum voltage drop and settling time of the source.
5) Contact voltage and contact current in accordance with Sub-clause 25.2.
6) Times to be measured and their limits, for a.c. point(s) on wave.
7) Further details required under Sub-clauses 25.2.4 and 25.2.5.
8) Contact(s) to be checked.
9) Discontinuities to be ignored if limit other than 10 μs.
10) Suppression components on coil or contact, if required.

26. Climatic sequence

26.1 Purpose: to determine the ability of the relay to withstand a sequence of climatic test conditions.

26.2 *Dry heat*

26.2.1 This test shall be carried out in accordance with test Ba or, if in relation to the test facilities the relay is to be considered as an appreciably heat-dissipating specimen, with test Bc of IEC Publication 68-2-2.

26.2.2 During the last two hours of the dry heat exposure time, the relay shall be energized as prescribed in the detail specification and as follows:

1) For relays for continuous duty, the energization value shall be applied continuously for the 2 h.
2) For relays for short-time or intermittent duty, the energization value shall be applied by pulses at the number of cycles per hour and the category duty cycle, both as declared by the manufacturer.
3) Contacts shall be loaded as prescribed in the detail specification.

26.2.3 Immediately following the two hours operating period and still under dry heat exposure, all categories of relays shall have a functional test as prescribed in the detail specification.

26.3 *Damp heat, cyclic, first cycle*

26.3.1 This test shall be carried out when prescribed in the detail specification.

26.3.2 This test shall be carried out in accordance with test Da of IEC Publication 68-2-4 for one cycle of 24 h, with the exception that the periodic variation in temperature shall be omitted.

26.3.3 Upon completion of the cycle, the relay shall be removed from the chamber, and exposed to the recovery conditions prescribed in the detail specification.

26.3.4 After recovery, the relay shall be immediately subjected to the cold test.

26.4 *Cold*

26.4.1 This test shall be carried out:

— for sealed relays: in accordance with test Aa;

— for unsealed relays: in accordance with test Ab of IEC Publication 68-2-1.

26.4.2 At the end of the conditioning period and before removal from the chamber, the relay shall be energized for 100 cycles at the energization value as prescribed in the detail specification.

26.4.3 During the operating tests, all contacts of application categories 1, 2 and 3 shall be loaded as prescribed in the detail specification. The contact function shall be checked as prescribed in the detail specification.

26.4.4 For contacts of application category 0, the 100 cycles shall be a miss-free test (the failure rate shall be nil). The contact circuit resistance shall be monitored, and at no time shall exceed the level prescribed in the detail specification.

26.5 *Low air pressure*

26.5.1 This test shall be carried out in accordance with test M of IEC Publication 68-2-13, and if prescribed in the detail specification.

26.5.2 At the end of the test period, and while the relay is still under low pressure, a dielectric test voltage as prescribed in the detail specification shall be applied between:

1) All terminals connected together and the exposed conductive parts.
2) The terminals of an open-circuit contact. Break contacts shall be opened for this test.

26.5.3 During the dielectric test, there shall be no flashover or breakdown of the insulation of the relay.

26.6 *Damp heat, cyclic, all or remaining cycles*

26.6.1 This test shall be carried out when prescribed in the detail specification

26.6.2 This test shall be carried out in accordance with test Da of IEC Publication 68-2-4, with the exception that the periodic variation of temperature shall be omitted. The number of cycles shall be in accordance with the detail specification.

Upon completion of the cycles, the relay shall be removed from the chamber and exposed to the recovery conditions prescribed in the detail specification.

26.7 *Intermediate measurements*

Intermediate measurements, if required, shall be made as prescribed in the detail specification.

26.8 *Final measurements*

26.8.1 After recovery of not less than one hour and not more than two hours, the relay shall be visually inspected in accordance with Clause 17. There shall be no evidence of corrosion, peeling or chipping, nor of mechanical deterioration that could impair operation.

26.8.2 Insulation resistance shall be measured in accordance with Clause 22. Degradation shall be permitted to the extent prescribed by the detail specification.

26.8.3 Contact circuit resistance shall be measured in accordance with Clause 23. Degradation shall be permitted to the extent prescribed by the detail specification.

26.8.4 Other final measurements, if required, as prescribed in the detail specification.

26.9 Conditions prescribed in the detail specification:

1) Degree of severity of the climatic conditions and recovery conditions.
2) Energization and contact load value during the last two hours of dry heat exposure, last 2 h.
3) Specification of the functional test after dry heat exposure.
4) Whether or not the damp heat, cyclic, first cycle test is required.
5) For the cold test, method Aa or Ab.
6) Energization value, contact load after cold exposure for 100 cycles and criteria of contact function, if required.
7) Whether or not the low pressure exposure is required.

8) Value of the test voltage during low pressure exposure.

9) Whether or not the damp heat, cyclic, all or remaining cycles test is required.

10) Permitted degradation in insulation resistance.

11) Permitted degradation in contact circuit resistance.

12) Mechanical deterioration to be checked.

13) Other final measurements, if required.

27. Damp heat, steady state

27.1 Purpose: to assess the suitability of the relay for use and/or storage under conditions of high relative humidity.

27.2 Procedure: this test shall be carried out in accordance with test Ca of IEC Publication 68-2-3. During the conditioning time of the relay, one half of the number of samples exposed shall have a potential of 100 ± 10 V d.c. or as prescribed in the detail specification, applied between the two ends of the coil connected together (positive) and all other terminations together with the exposed conductive parts (negative).

At the end of the exposure period, the relays shall be removed from the chamber and exposed to the recovery conditions prescribed in the detail specification.

27.3 Conditions prescribed in the detail specification:

1) Duration of the conditioning and recovery conditions.

2) Voltage to be applied if other than 100 ± 10 V d.c.

3) Final measurements:

   a) Visual inspection as specified in Clause 17. There shall be no evidence of corrosion, peeling or chipping, nor of mechanical deterioration that could impair operation.

   b) Insulation resistance as specified in Clause 22, and the extent of degradation permitted.

   c) Contact circuit resistance as specified in Clause 23, and the extent of degradation permitted.

   d) Other final measurements, if required.

28. Thermal resistance

28.1 Purpose: to determine whether the heat dissipation of the relay is within the specified limits.

28.2 Procedure: the relay shall be mounted as specified in the detail specification. The relay shall be energized successively at four values approximately equally distributed throughout its operative range, and the temperature rise shall be determined for each of them after thermal equilibrium has been reached. All measurements shall be made at a constant ambient temperature within the limits of Sub-clause 16.1, and the relay shall be protected from draughts, solar irradiation and the like.

The temperature rise shall, for coils made of one conductor material, be calculated by the formula.

$$\Delta t_w = \frac{R_w - R_a}{R_a}\left(t_a + \frac{1}{\alpha_0}\right) \quad [°C]$$

This formula can be held valid for temperatures between 0°C and 120°C, and contains:

Δt_w = average temperature rise

R_w = resistance of the coil under load in thermal equilibrium

R_a = resistance of the coil at ambient temperature

t_a = ambient temperature

α_0 = temperature coefficient of the resistivity of the conductor material at 0°C. For copper α_0 is equal to

$$\frac{1}{235} \quad (K^{-1})$$

From the temperature rise, the thermal resistance is calculated by the formula:

$$R_{th} = \frac{\Delta t_w}{p_w} \quad (K/W)$$

wherein p_w = value of the power supplied to the coil at thermal equilibrium.

The value to be compared with the specified value is, unless otherwise prescribed in the detail specification, the average of the results of the four measurements.

28.3 Conditions prescribed in the detail specification:

1) Mounting of the relay.
2) Energization values if other than the four values equally distributed throughout the operative range.
3) Temperature coefficient of the wire material, if other than electrolytic copper.
4) Evaluation procedure if other than the average value of the four measurements is required.
5) Limits of thermal resistance.
6) Contact load, if required.

29. Temperature rise

29.1 Purpose: to determine that the temperature rise of the relay does not exceed the specified limits.

29.2 Procedure: the relay shall be mounted and energized as prescribed in the detail specification. The temperature rise of the coil shall be determined

a) for relays for continuous duty: after thermal equilibrium has been reached;

b) for relays for short-time or intermittent duty: at the highest temperature attained during such operation.

The test shall be carried out at constant ambient temperature within the limits of Sub-clause 16.1, unless otherwise prescribed in the detail specification, and the relay shall be protected from draughts, solar irradiation and the like.

The average temperature rise of the coil shall be calculated according to the formula given in Sub-clause 28.2.

29.3 Conditions prescribed in the detail specification:

1) Mounting of the relay.
2) Value and, if applicable, duration of energization.
3) Temperature coefficient of the wire material, if other than electrolytic copper.

4) Ambient temperature, if other than in Sub-clause 16.1.
5) Contact load, if required.
6) Limits of temperature rise.

30. Rapid change of temperature

30.1 Purpose: to determine the ability of the relay to withstand rapid changes of air temperature.

30.2 *Procedure*

Method 1: the test shall be carried out in accordance with test Na of IEC Publication 68-2-14.

Method 2: the test shall be carried out in accordance with test Nc of IEC Publication 68-2-14

30.3 Conditions prescribed in the detail specification:

1) Method 1 or 2.
2) Temperature extremes and duration.
3) Contact load, if required.
4) Final measurements.
   a) Visual inspection as specified in Clause 17. There shall be no evidence of corrosion, peeling or chipping, nor of mechanical deterioration that could impair operation.

   b) Insulation resistance as specified in Clause 22.

c) Contact circuit resistance as specified in Clause 23.
The contact circuit resistance shall not exceed twice the specified initial value.

d) Other final measurements, if required.

31. Enclosure

31.1 Purpose: to determine the effectiveness of relay enclosure or the contact capsule. It may determine the effectiveness of either the sealing or the protection against sand and dust.

31.2 *Sealing*

31.2.1 *Procedure*

Method 1: this test shall be carried out in accordance with the procedures of test Qc, method 2, of IEC Publication 68-2-17.

Method 2: this test shall be carried out in accordance with the procedures of test Qk of IEC Publication 68-2-17. Where method 2 is used, it shall be preceded or followed by method 1 if so prescribed in the detail specification.

If the time interval between sealing and testing has been more than 48 h, the relay shall be exposed to an atmosphere of helium at high pressure.

The difference pressure and the duration of exposure shall be as prescribed in the detail specification.

After the exposure, the absorbed helium shall be cleaned from the surface as prescribed in the detail specification.

Method 3: for relay capsules a krypton detection method is acceptable (see Sub-clause 7.3 in IEC Publication 147-5, Essential Ratings and Characteristics of Semiconductor Devices and General Principles of Measuring Methods, Part 5: Mechanical and Climatic Test Methods).

31.2.2 Conditions prescribed in the detail specification:

1) Method or sequence of methods (1 and/or 2).
2) Method 2: permitted leakage rate, chosen from one of the following: 10^{-6}, 10^{-7} or 10^{-8} mbar . l/s.
3) Pressurizing, and cleaning procedures.
4) Method 3: details of method and limits.

31.3 *Sand and dust*

31.3.1 Procedure: the test for enclosed relays and non-hermetically sealed relays only shall be carried out in accordance with IEC Publication 144: Degrees of Protection of Enclosures for Low-voltage Switchgear and Controlgear.

31.3.2 Conditions prescribed in the detail specification:

1) First characteristic numeral, to be chosen from 1 to 4.

32. Internal moisture

32.1 This test is applicable only to those relays to which the methods 2 and 3 of Sub-clause 31.2 are applicable.

32.2 Purpose: to determine whether internal moisture has an adverse effect on the contact resistance.

32.3 Procedure: the relay coil shall be energized as prescribed in the detail specification. The relay is under its maximum rated temperature, for one hour, and then under the minimum rated temperature for one additional hour. At the end of the low temperature exposure, the coil shall be de-energized and the opening of the contacts, previously closed, is checked. For bistable relays, rated release value shall be momentarily applied to cause the contacts to transfer.

32.4 Conditions prescribed in the detail specification:

1) Energization value.
2) Maximum and minimum rated temperatures.
3) Final measurement: static resistance of one of the closed contacts, and as specified in Clause 23.

33. Corrosive atmospheres

33.1 *Salt mist*

33.1.1 This test is applicable only to those relays to which the methods 2 and 3 of Sub-clause 31.2 are applicable.

33.1.2 Purpose: to assess the suitability of the relay for use and/or storage in a salt-laden atmosphere

33.1.3 Procedure: the test shall be carried out in accordance with test Ka of IEC Publication 68-2-11 Upon completion of the exposure period, the relay shall be removed from the chamber anc exposed to the recovery conditions prescribed in the detail specification.

33.1.4 Conditions prescribed in the detail specification:

1) Duration: severity I or severity II.
2) Recovery conditions.
3) Final measurements:
    a) Visual inspection as specified in Clause 17. There shall be no evidence of corrosion, peeling or chipping, nor of mechanical deterioration that could impair operation.
    b) Insulation resistance as specified in Clause 22. The initial limit shall apply.

33.2 *Other corrosive atmospheres*

No requirements at present

34. Mould growth

34.1 Purpose: to assess the extent of mould growth on a relay, or the effect of mould growth on the function of a relay.

34.2 Procedure: the test shall be carried out in accordance with test J of IEC Publication 68-2-10, and — regarding test duration, initial measurements and final examination — as prescribed in the detail specification.

34.3 Conditions prescribed in the detail specification:

1) All details following letters *a)* to *g)* of Clause 8 of IEC Publication 68-2-10.

35. Robustness of terminals

35.1 Purpose: to determine the ability of terminals to withstand direct axial pulls, bending or twisting, and nuts and threaded terminals to withstand torques likely to be experienced during normal assembly operations.

35.2 Procedure: terminals shall be subjected to test Ua, Ub, Uc or Ud of IEC Publication 68-2-21 as appropriate.

35.3 Conditions prescribed in the detail specification:

1) Tests Ua, Ub, Uc or Ud and corresponding loads.

2) Final measurements:
   a) Visual inspection as specified in Clause 17.
   b) Coil resistance as specified in Sub-clause 19.1.
   c) Contact circuit resistance as specified in Clause 23.
   d) Other final measurements if required.

36. Soldering

36.1 This test is applicable only to relays with solder terminals.

36.2 Purpose: to determine the ability of relay terminals to wet easily with solder, and/or the ability of the relay to withstand soldering heat.

36.3 Procedure: prior to the tests, printed wiring terminals shall be fitted with a 1.5 ± 0.5 mm thickness thermal screen, and shall be immersed no further than the underside of that screen.

Test 1: solderability. The test shall be conducted in accordance with the procedures for solderability described in method 1, 2 or 3 of test Ta of IEC Publication 68-2-20, as prescribed in the detail specification.

Test 2: resistance to soldering heat. The test shall be conducted in accordance with one of the procedures for resistance to soldering heat of test Tb of IEC Publication 68-2-20, as prescribed in the detail specification.

36.4 Conditions prescribed in the detail specification:

1) Test 1 or 2 (or both), and the methods in either of them.

2) Test 1: ageing procedures if required.

3) Final measurements:

   a) Visual inspection as specified in Clause 17 for test 1 extended by examination of the solder wetting.

   b) Coil resistance as specified in Sub-clause 19.1.

   c) Other final measurements if required.

37. Shock

37.1 Purpose: to prove the capability of the relay to function during and/or after non-repetitive shocks, encountered in service or during transportation.

37.2 Procedure: the test shall be conducted in accordance with test Ea of IEC Publication 68-2-27.

Method 1: capability to function during shocks. During this test, the relay shall be subjected to one series of shocks whilst being in its operate condition and one further series whilst being in its release condition. Both series of tests shall be performed in both directions of each of the three mutually perpendicular axes.

During the test, the contact action shall be monitored. No opening or closing of any closed or opened contact circuit respectively shall exceed 10 µs, unless another value is prescribed in the detail specification, both whilst the relay is in operate condition and in release condition.

The contact load shall be as prescribed in the detail specification.

Method 2: capability to function after shocks. During this test, the relay shall be subjected to a series of shocks in both directions of each of the three mutually perpendicular axes. The relay shall not be energized, and the contacts shall not be monitored.

37.3 Immediately following the shock test (method 1 or 2), the relay shall be operated ten times with the rated energization value applied to the coil.

37.4 Conditions prescribed in the detail specification:

1) Method 1 or 2.
2) Pulse shape and peak acceleration.
3) Method of mounting.
4) Permitted duration of opening or closing, if other than 10 µs, and detail of monitoring device, e.g. storage oscilloscope.
5) Method 1:
    a) Energization value, preferably the lower limit of the operative range (for monostable and bistable relays).
    b) Contact load.
6) Final measurements:
    a) Visual inspection as specified in Clause 17.
    b) Method 1: contact circuit resistance as specified in Clause 23: initial value.
    c) Method 2: contact circuit resistance as specified in Clause 23. The resistance shall not exceed twice the initial specified value.
    d) Other final measurements, if required.

38. Bump

38.1 Purpose: to prove the capability of the relay to function during and/or after repetitive bumps encountered in service or during transportation.

38.2 Procedure: the test shall be conducted in accordance with test Eb of IEC Publication 68-2-29, at a peak acceleration as stated in the detail specification.

Method 1: capability to function during bumps. During this test, the relay shall be subjected to one half of the total number of bumps whilst being in its operate condition and the other half of the total number of bumps whilst being in its release condition. Both series of tests shall be performed in both directions of each of the three mutually perpendicular axes.

During the test, the contact action shall be monitored. No opening or closing of any closed or opened contact circuit, respectively, shall exceed 10 µs, unless another value is prescribed in the detail specification, both whilst the relay is in operate condition and in release condition.

The contact load shall be as specified in the detail specification.

Method 2: capability to function after bumps. During this test, the relay shall be subjected to the required number of bumps in each direction of the three mutually perpendicular axes. The relay shall not be energized, and the contacts shall not be monitored.

38.3 Immediately following the bump test (method 1 or 2), the relay shall be operated ten times with the rated energization value applied to the coil.

38.4 Conditions prescribed in the detail specification:

1) Method 1 or 2.
2) Peak acceleration and number of bumps.
3) Method of mounting.
4) Permitted duration of opening or closing, if other than 10 µs, and detail of monitoring device, e.g. storage oscilloscope.
5) Method 1:
   a) Energization value, preferably the lower limit of the operative range (for monostable and bistable relays).
   b) Contact load.
6) Final measurements:
   a) Visual inspection, as specified in Clause 17.
   b) Method 1: contact circuit resistance as specified in Clause 23: initial value.
   c) Method 2: contact circuit resistance as specified in Clause 23. The resistance shall not exceed twice the initial specified value.
   d) Other final measurements, if required.

39. Vibration

39.1 Purpose: to prove the capability of the relay to withstand conditions of vibration.

39.2 Procedure: this test shall be carried out in accordance with Procedure A of test Fc of IEC Publication 68-2-6 unless another procedure of IEC Publication 68 is prescribed in the detail specification.

During vibrations the relay shall be alternately in its operate condition and in its release condition, the change in condition being synchronized with the completion of each vibration sweep cycle.

During this test, care shall be taken to make sure that the stray field of the vibration generator does not affect the relay.

During the vibration test, the contact action shall be monitored. No opening or closing of any closed or opened contact circuit respectively shall exceed 10 μs, unless another value is prescribed in the detail specification, both whilst the relay is in operate condition and in release condition.

The relay shall be subjected to the vibrations following three mutually perpendicular axes.

The contact load shall be as prescribed in the detail specification.

Immediately following the vibration test, the relay shall be operated ten times with the rated energization value applied to the coil.

39.3 Conditions prescribed in the detail specification:

1) Amplitude or acceleration level, duration and frequency range.
2) Energization value, preferably the lower limit of the operative range (for monostable and bistable relays).
3) Method of mounting.
4) Permitted duration of opening or closing, if other than 10 μs, and details of monitoring, e.g storage oscilloscope.
5) Contact load.
6) Final measurements:
   a) Visual inspection as specified in Clause 17.
   b) Insulation resistance as specified in Clause 22.
   c) Contact circuit resistance as specified in Clause 23. The resistance shall not exceed twice the initial specified value.
   d) Other final measurements if required.
7) Procedure, if other than test Fc of IEC Publication 68-2-6, and required details.

40. Acceleration

40.1 Purpose: to prove the capability of the relay to function during and/or after subjecting to forces produced by steady acceleration environments (such as moving vehicles, aircraft and projectiles).

40.2 Procedure: this test shall be carried out in accordance with test Ga of IEC Publication 68-2-7.

Method 1: capability to function during acceleration. During this test, the relay shall be in its operate condition for 50% of the time of exposure. During the remaining 50% of the time of exposure, the relay shall be in its release condition. Both exposures shall be performed in both directions of each of the three mutually perpendicular axes.

During the acceleration, the contact action shall be monitored. No opening or closing of any closed or opened contact circuit respectively shall exceed 10 μs, unless another value is prescribed in the detail specification, both whilst the relay is in operate condition and in release condition.

The contact load shall be as prescribed in the detail specification.

Method 2: capability to function after acceleration. During this test, the relay shall be subjected to the required acceleration in both directions of each of the three mutually perpendicular axes. The relay shall not be energized, and the contacts shall not be monitored.

40.3 Immediately following the acceleration test (method 1 or 2), the relay shall be operated ten times with the rated energization value applied to the coil.

40.4 Conditions prescribed in the detail specification:

1) Method 1 or 2.
2) Acceleration and if required, duration.
3) Method of mounting.
4) Permitted opening or closing time, if other than 10 μs and detail of monitoring device e.g. storage oscilloscope.
5) Method 1:
   a) Energization value, preferably the lower limit of the operative range (for monostable and bistable relays).
   b) Contact load.
6) Final measurements:
   a) Visual inspection as specified in Clause 17.
   b) Method 1: contact circuit resistance as specified in Clause 23: initial value.
   c) Method 2: contact circuit resistance as specified in Clause 23. The resistance shall not exceed twice the initial specified value.
   d) Other final measurements, if required.

41. Electrical endurance

41.1 Purpose:

a) To check the performance of the relay under operating conditions and for the number of cycles specified in the detail specification in accordance with IEC Publication 255-0-20 (1974), Contact Performance of Electrical Relays, Sub-clause 5.2.1.1.

b) To establish reliability data in accordance with IEC Publication 255-0-20, Sub-clause 5.2.1.2, relating to a clearly defined application.

41.2 General procedure: during all tests, the relay mounting face and any exposed metallic parts shall be connected to the power supply negative and/or neutral point, via a fuse rated at 5% of the maximum contact current or 100 mA, whichever is the greater, unless otherwise prescribed in the detail specification. The fuse shall not blow during the test.

The relay shall be energized at its rated energization value or at the centre value of its operative range, and the test shall be conducted at ambient room temperature within the limits of Sub-clause 16.1, unless otherwise prescribed in the detail specification. The switching action shall not be synchronous with the source of the load circuit, if this is a.c.

41.3 Endurance test: application categories 1, 2 and 3 contacts.

41.3.1 The contact loading shall be resistive, inductive, lamp or motor load — d.c. or a.c. at 50 Hz or 60 Hz — in accordance with the detail specification. Endurance tests at each appropriate load shall be carried out. Where relays have more than one type of load rating, these shall be applied to separate contact circuits of the same relay, if so prescribed in the detail specification.

The relay shall be subjected to the number of cycles prescribed in the detail specification, and the contact action shall be monitored in accordance with one of the following methods:

Method 1: continuous checking. During the test, the contact action shall be monitored. At any time during the test, the accumulated number of false contact cycles shall not be greater than that prescribed in the detail specification.

Method 2: intermediate checking. During the test, the contact action shall be verified by measurements at the completion of 10%, 50%, and 75% of the prescribed cycles or at intervals prescribed in the detail specification, the criterion of failure being as prescribed in the detail specification.

41.3.2 Conditions prescribed in the detail specification:

1) Total number of cycles or duration for each contact and number of contacts to be tested simultaneously or not.
2) Method 1 or 2.
3) Method 1: allowable difference between number of coil pulses and contact cycles.
4) Method 2: checking intervals if other than after completion of 10%, 50%, and 75% of the prescribed cycles.
5) Criteria of contact failure (see IEC Publication 255-0-20, Sub-clause 4.4).
6) Temperature, if other than in Sub-clause 16.1.
7) Energization value and, if required, frequency.
8) Number of cycles per hour and duty factor.
9) Protective and spark quenching devices, if required.
10) Details of checking equipment, adaptors etc., if required, and fuse rating if other than 5% or 100 mA.
11) Load:
    a) The specified values shall be maximum rated continuous, make or break load.
    b) The specified values shall be either d.c., or a.c. with preference to 50 Hz or 60 Hz.
    c) For application category 1 contacts, an additional test shall be made with contacts loaded at the specified minimum voltage and current, and prior to the test at maximum conditions.

The form of load shall be as follows:

Resistive load: the contacts shall be loaded to specified voltage and current using resistors of low inductance.

Inductive load: the contacts shall be loaded to specified voltage and current using a specified inductive load.

Lamp load: the load shall consist of a specified number of metal filament lamps which shall be operated at their rated voltage. The specified current is that which flows when the lamp has stabilized.

Motor load. Unless otherwise specified in the detail specification, a resistive load shall be used to establish a comparative test. The resistive load current shall be five times the rated motor load current. Where the rated motor load is not greater than one-fifth of the rated resistive load, and the rated duty cycle and load factor are identical, this test need not be carried out in addition to the resistive load test.

Capacitive load: no requirements at present.

Cable load: a quad cable of specified design and length shall be used. Its a-cores shall be connected to the relay contact under test, and shall be either charged by an external source but left open (cable discharge test) or shall be fed from an external source via other cores and resistors (mixed cable and resistive load). The remaining cores and the cable jacket shall be earthed. All further details or different types of cables shall be as prescribed in the detail specification.

12) Final measurements:

  a) Insulation resistance as specified in Clause 22.
  b) Contact circuit resistance as specified in Clause 23.
  c) Any other measurements, if required.

41.4 Endurance test: application category 0 contacts.

41.4.1 Loading: the contact voltage shall be 30 mV maximum and the contact current 10 mA maximum. These values may be a.c. r.m.s. or d.c.

The contact circuit resistance shall be monitored for each cycle for resistance of each pair of mating contacts. The test equipment shall automatically cut out when a contact failure occurs or when the permissible number of failures has been exceeded, or shall record any failure. This contact failure shall be stated as a maximum contact circuit resistance value given in the endurance clause of the detail specification. Measuring current shall be applied after all contacts are closed, and removed before any of the contacts is opened, except if the measuring current is also the load current (see note in Sub-clause 23.1).

41.4.2 Conditions prescribed in the detail specification:

1) Permitted number of contact failures.
2) Energization value.
3) Number of cycles per hour and duty factor.
4) Total number of cycles or duration for each contact and number of contacts to be tested simultaneously or not.
5) Maximum contact circuit resistance.
6) Temperature, if other than in Sub-clause 16.1.

7) Intermediate measurements if required.

8) Final measurements:

   a) Insulation resistance as specified in Clause 22.

   b) Any other measurements if required.

41.5 Endurance test, miss-free acceptance, for application category 0 contacts, or contacts of category 1 with category 0 capabilities.

41.5.1 Loading: the contact voltage shall be 30 mV maximum and the contact current 10 mA maximum. The test shall be made before any rated loads, other than category 0, are applied to the contact circuits.

The contact circuit resistance shall be monitored for each cycle for resistance for each pair of mating contacts. The test equipment shall automatically cut out when a contact failure occurs. This contact failure shall be stated as a maximum contact circuit resistance value given in the endurance clause of the detail specification. Measuring current shall be applied after all contacts are closed, and removed before any of the contacts is opened, except if the measuring current is also the load current (see note in Sub-clause 23.1).

41.5.2 Conditions prescribed in the detail specification:

1) Energization value.

2) Total number of cycles as a percentage of the prescribed life (R5 series ISO 3) for each contact and number of contacts to be tested simultaneously or not.

3) Number of cycles per hour and duty factor.

4) Maximum contact resistance.

5) Intermediate measurement if required.

6) Final measurements:

   a) Insulation resistance as specified in Clause 22.

   b) Any other measurements if required.

7) Extended assessment if required (see below).

41.6 *Extended assessment*

41.6.1 This test shall be carried out if prescribed by the detail specification.

41.6.2 This test shall be conducted in accordance with IEC Publication 255-0-20, Sub-clause 5.2.1.2.

41.6.3 Conditions prescribed in the detail specification:

1) All information required under the above sub-clause.

42. Mechanical endurance

42.1 Purpose: to assess the mechanical performance of relays under rated energization conditions over an extended number of cycles.

42.2 Procedure: the relay shall be energized as prescribed in the detail specification, and the test shall be conducted at ambient room temperature within the limits of Sub-clause 16.1. The switching action shall not be synchronous with the source of the monitoring circuit, if this is a.c.

During the test, any routine maintenance or replacement recommended by the manufacturer is permissible, but no other parts may be replaced.

42.3 *Check of performance*

Method 1: continuous checking. The mechanical operation of the relay shall be monitored electrically, using a load as prescribed in the detail specification. At any time during the test, the accumulated number of false cycles shall not be greater than that prescribed in the detail specification.

Method 2: intermediate checking. After each 20% of the rated mechanical lifetime, intermediate measurements shall be made, as prescribed in the detail specification.

42.4 Conditions prescribed in the detail specification:

1) Method 1 or 2, or both.
2) Energization value.
3) Monitoring voltage and current, such as not to cause an electrical endurance failure of the relay.
4) Number of cycles per hour and duty factor.
5) Total number of cycles or duration for each contact and number of contacts to be tested simultaneously or not.
6) Method 1: allowable number of false contact cycles.
7) Method 2: tests to be performed during intermediate checking, and required results.
8) Final measurements:
   a) Visual inspection as specified in Clause 17.
   b) Insulation resistance as specified in Clause 22 and permissible degradation.
   c) Contact circuit resistance as specified in Clause 23.
   d) Any other measurements if required.

43. Thermal endurance

43.1 Purpose: to assess the effect of high temperature conditions on the relay when energized for long periods.

43.2 Procedure: the test shall be carried out at the upper value of the temperature range with the relay energized as prescribed in the detail specification, and with at least half of the make contact circuits carrying maximum rated current.

43.3 Conditions prescribed in the detail specification:

1) Method of mounting.
2) Duration (1 000 h minimum).

3) Ambient temperature.

4) Energization value.

5) Final measurements:

  a) D.C. coil resistance as specified in Sub-clause 19.1.

  b) Insulation resistance as specified in Clause 22.

  c) Functional tests as specified in Clause 24.

  d) Other final measurements if required.

44. Limiting continuous current

44.1 Purpose: to assess the suitability of the contacts to carry the limiting continuous current.

44.2 Procedure: the relay shall be energized as prescribed in the detail specification. The closed make contacts shall then be loaded with the specified continuous contact current for sufficient time to ensure that the contacts reach thermal equilibrium. After this, the current shall be taken away and, while the relay is kept energized and is not mechanically touched, the actual release time of the make contact shall be measured as specified in Clause 25.

Break contacts shall be loaded with the specified continuous contact current while the relay is unenergized. After thermal equilibrium, this current shall be interrupted and the actual operate time of the break contact shall be measured.

The actual release time of make contacts and the actual operate time of break contacts, shall not exceed the specified values. After the test, the contact resistance shall not exceed the specified value

44.3 Conditions prescribed in the detail specification:

1) Energization value.

2) The limiting continuous current for make contacts.

3) The limiting continuous current for break contacts.

4) Operate time and release time.

5) The contact circuit resistance.

6) Any deviation of the test method.

45. Overload (contact circuits)

45.1 Purpose: to assess the performance of a relay when subjected to fault conditions.

45.2 Procedure: during the test, the relay mounting face and any exposed metallic parts shall be connected to the power supply negative and/or neutral point, via a fuse rated at 5% of the maximum contact current, or 100 mA, whichever is the greater, unless otherwise prescribed in the detail specification.

The number of cycles shall be 100±2 for d.c. contact loads, and 200±2 for a.c. contact loads unless otherwise prescribed in the detail specification.

45.2.1 D.C. Loads: the relay coil shall be energized as specified in the detail specification and subjected to the appropriate number of cycles at the rated duty factor, with the contacts switching twice their maximum rated current for a resistive load at their maximum rated voltage, unless otherwise prescribed in the detail specification.

45.2.2 A.C. Loads: the relay shall be energized as prescribed in the detail specification, and subjected to the appropriate number of cycles at the rated duty factor, with the contacts switching twice their maximum rated current for an inductive load at their rated voltage, unless otherwise prescribed in the detail specification.

The relays shall make and break the above loads, and the fuse shall not blow.

45.3 Conditions prescribed in the detail specification:

1) Method of mounting.
2) Energization value.
3) Contact current (fault condition) if other than twice the maximum rated current.
4) Total number of cycles if other than in Sub-clause 45.2.
5) Any specific operating conditions to enable the relay to meet its performance as declared by the manufacturer and the number of contacts simultaneously loaded.
6) Fuse rating if other than 5% or 100 mA.

46. Load transfer

46.1 Purpose: to check that the relay is capable of changing over a three-phase load from one three-phase source to another.

46.2 Procedure: the relay shall be connected to a test circuit as shown in Figure 8, page 49, the voltage, frequency and load being as prescribed in the detail specification. During the test, the relay mounting parts and any exposed conductive parts shall be connected to the common point of the load, via a fuse rated at 5% of the rated load current, or 100 mA, whichever is the greater, unless otherwise prescribed in the detail specification.

The relay shall be operated for the number of cycles prescribed in the detail specification. Continuous monitoring shall be used to detect phase-to-phase arcing and contact welding. The fuse shall not blow during the test.

Unless otherwise specified, the relay shall be 5 ± 1 s in the operate condition and 5 ± 1 s in the release condition for each cycle.

46.3 Conditions prescribed in the detail specification:

1) Energization value.
2) Voltage and frequency of the three-phase source.
3) Load parameters.
4) Fuse rating, if other than 5% or 100 mA.
5) Number of cycles, and times, if other than 5 + 1 s.

6) Final measurements:
   - *a)* Dielectric test as specified in Clause 20.
   - *b)* Insulation resistance as specified in Clause 22.
   - *c)* Contact circuit resistance as specified in Clause 23.

47. Electromagnetic compatibility

No requirements at present.

Note. — While future wording of this clause will deal with phenomena such as radio interference and transient voltages, attention is drawn to the fact that tests on these phenomena can be carried out only when the relay is connected to a circuit.

48. Magnetic interference

48.1 Purpose: to check that the values of functional performance of the relay remain within specified limits when the relay is subjected to the effects of external magnetic inductions.

48.2 *Procedure*

Method 1: the relay shall be mounted by suitable non-magnetic means within the central volume of a test coil. The axis of maximal sensibility of the relay shall be aligned with the longitudinal axis of the test coil. Operate and release values shall be measured, as specified in Clause 24 in zero magnetic field in air and

— for magnetically shielded relays in 8×10^3 A/m;

— for all other relays in 0.8×10^3 A/m,

magnetic field of both polarities.

Method 2: the relay under test and eight similar relays shall be mounted in the same physical orientation by non-magnetic means, as shown in Figure 9, page 49. Operate and release values of the relay under test shall be measured as specified in Clause 24, with the coils of the eight outer relays energized at rated value, and with the coils not energized. The magnetic polarity of each relay shall be similarly orientated.

48.3 Conditions prescribed in the detail specification:

1) Method 1 or 2.
2) Method 1: dimensions of the test coil.
3) Method 2: mounting grid pattern
4) Any particular procedure, if the above are not applicable.
5) Admissible limits of the operate and release values.

49. Crosstalk and insertion loss

No requirements at present.

Note. — Attention is drawn to the fact that tests on crosstalk and insertion loss can be carried out only when the relay is connected to a circuit.

50. Electrical contact noise

50.1 Purpose: to check that the electrical noise produced by relay contacts in a circuit does not exceed specified limits under specified conditions.

50.2 Procedure: the relay is energized at a value (at values) as specified in the detail specification. The relay is subjected to shock and vibration only, if specified in the detail specification. The relay contact is inserted in a circuit formed of a resistor (or resistors), and of a voltage source if specified in the detail specification. The noise across the relay contact or across a resistance is measured by an oscilloscope, or by a noise-level meter, with a filter inserted or not, as prescribed in the detail specification.

50.3 Conditions prescribed in the detail specification:

1) Energization value(s).
2) Shock and/or vibration parameters, if required.
3) Test circuit.
4) Measuring equipment.
5) Limits of noise voltage.

51. Thermoelectric e.m.f.

51.1 Purpose: to check that the e.m.f. generated by relay contacts subjected to elevated temperatures, does not exceed specified limits.

51.2 Procedure: the terminals of a make contact shall be soldered to bare copper wires. The bare copper wires shall be connected to measuring equipment, maintained at room temperature. The relay shall be within ±5°C of its maximum temperature. The coil shall be energized at its rated value. After thermal equilibrium has been reached, or after 4 h, whichever is the shorter, the voltage across the bare copper wires shall be measured.

51.3 Conditions prescribed in detail specification:

1) Method and material for soldering.
2) Ambient temperature of the test chamber.
3) Limit of e.m.f.

52. Capacitances

52.1 Purpose: to check that the capacitances formed by parts of the relay do not exceed specified limits.

52.2 Procedure: the capacitances shall be measured by means of a measuring bridge, at a frequency of 1 kHz, and at a voltage not exceeding 10 V, unless otherwise prescribed in the detail specification.

52.3 Conditions prescribed in the detail specification:

1) Measuring frequency and voltage, if other than 1 kHz and 10 V.

2) Points of measurement(s) and points to be earthed.

3) Limiting value(s) of capacitances.

53. Contact sticking

53.1 Purpose: to check that closed contacts of a relay do not fail to open within specified time, due to effects of remanence, chemical effects, or high temperature.

53.2 Procedure: the relay shall be energized for 24 h at the upper limit of its operative range, beginning at room temperature.

Within 1 h after the beginning, the temperature shall be increased to, and maintained for the remaining time at the maximum rated ambient temperature. No load shall be applied to the contacts. At the end of this period, without physically disturbing the relay, the coil shall be de-energized, and the release time shall be measured as in Clause 25.

53.3 Conditions prescribed in the detail specification:

1) Upper limit of the operative range.

2) Limit of release time.

54. Magnetic remanence

54.1 Purpose: to check that the effect of remanence in the relay core, from one cycle to the next, does not exceed the specified limits.

54.2 Procedure: this test is only applicable to relays with d.c. energization. Influences of external fields shall remain constant during the test. Contact circuits shall be monitored throughout the test for failure to make or to break at the appropriate values of energization. For the energization, current values only shall be considered so as to avoid effects of changes in coil resistance. The test is carried out in four steps, as follows:

a) The relay is energized at a specified saturate value and, unless otherwise prescribed, for a period of at least 20 ms. The relay shall then be in operate condition. The energization shall then be reduced to zero, and shall remain at zero for at least a further 20 ms. The relay shall now be in release condition.

b) The energization value shall be increased from zero, at the same polarity as under step *a)*, until the relay operates, and the actual operate value shall be measured.

c) The energization shall be reduced and changed from the actual operate value through zero to the specified reverse saturate value, and shall, unless otherwise prescribed, remain at that value for at least 20 ms.

d) The energization shall be reduced and changed from the reverse saturate value through zero until, at the same polarity as under steps *a)* and *b)*, the relay operates, and the actual operate value shall be measured again.

The remanence rate, in per cent, is equal to:

$$100 \times \frac{\text{actual operate value } b - \text{actual operate value } d}{\text{actual operate value } b}$$

It shall not exceed the value prescribed in the detail specification.

54.3 Conditions prescribed in the detail specification:

1) Saturate value and reverse saturate value, and duration of application if other than 20 ms.
2) Criteria for contact making and, if necessary, for contact breaking.
3) Limits of remanence value.

55. **Acoustic noise**

No requirements at present.

56. **Continuity of protective earth connection**

56.1 Purpose: to ensure that an installation fuse blows when current-carrying parts and accessible conductive parts are accidentally short-circuited. This test applies to relays for mains circuits only which are provided with a protective earth terminal.

56.2 Procedure: the resistance between the accessible conductive parts and the protective earth terminal shall be measured by an ohmmeter or as prescribed in the detail specification.

56.3 Conditions prescribed in the detail specification:

1) Test procedure, if required.
2) Limit of resistance.

57. **Fluid contamination**

57.1 Purpose: to ensure that the relay is suitable for use when subjected to contamination by fluids found in aerospace applications and similar.

57.2 Procedure: the relay (and its socket, if applicable) shall be freely suspended in a test chamber, in which the temperature shall be maintained as stated in Table II. It shall be sprayed with the fluid selected from that table, so that it is thoroughly wetted. It shall be kept in the chamber at the stated temperature for not less than 48 h. The relay shall then be removed from the chamber and allowed to regain room temperature.

A separate relay shall be used for each test fluid.

57.3 Conditions prescribed in the detail specification:

1) Test fluid or fluids.
2) Any deviations from the above procedure.

3) Any permitted degradation during the final tests.

4) Final measurements:

   a) Visual inspection, as specified in Clause 17:

   b) Dielectric test, as specified in Clause 20.

   c) Insulation resistance, as specified in Clause 22.

   d) Operate and release values, as specified in Clause 24.

   e) Sealing, if applicable, as specified in Sub-clause 31.2.

TABLE II

Test fluids and temperatures of tests

Fluid represented	Test fluid	Temperature of test (°C)
Fuel	70% isooctane and 30% toluene by volume	20±5
Hydraulic fluid	(1) 80% ethylene glycol monoethyl ether and 20% castor oil by volume	50±2
	(2) Ester based synthetic hydraulic fluid	70±2
	(3) Silicone based (high temperature) hydraulic fluid	70±2
Lubricating oil	Ester based lubricating oil	100±2
Cleaning fluid	Trichloroethylene[1]	20±5

[1] Warning: Trichloroethylene is likely to present a toxic hazard.

58. Resistance to solvents

No requirements at present.

Explanatory notes concerning performance diagrams, Figures 1 to 5 hereafter

The drawings are not to scale.

The preconditioning pulses are examples only. Any other waveform direction, duration or amplitude may be used.

The sequence of Figure 5, page 46, bistable polarized relay, is an example only. Other sequences might apply to further types of such relays.

Diagram codes:

a	non-operate value
b	operate value
c	rated value
d	non-revert value
e	non-release value (monostable relays)
f	release value (monostable relays)
g	non-release value (bistable relays)
h	release value (bistable relays)
i	reverse rated value
j	reverse non-revert value
k	reverse polarity value
x	conditioning value
y	setting value
z	reverse setting value

The upper traces each represent the energization values, the lower traces indicate the condition of the contact (0 = release condition, 1 = operate condition).

Reference of Figures 1 to 5: Clauses 7 and 24.

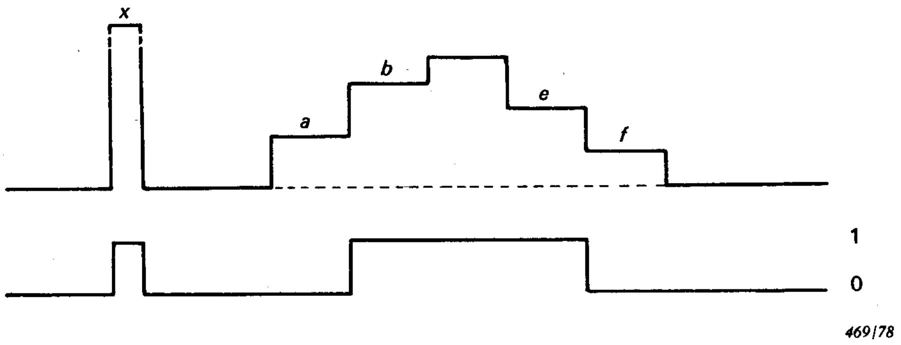


FIG. 1. — Monostable non-polarized relay.

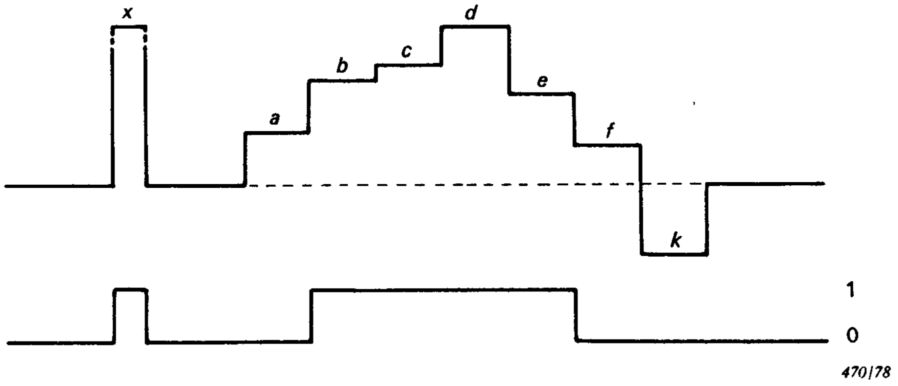


FIG. 2. — Monostable relay polarized by diode.

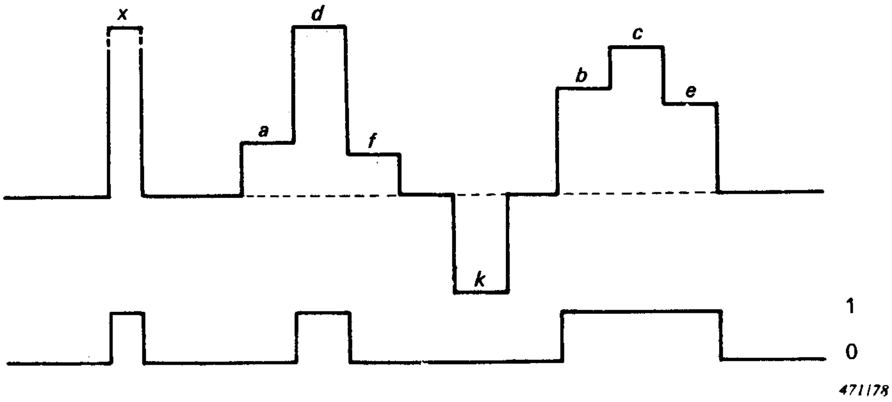


FIG. 3. — Monostable polarized with magnetic biasing.

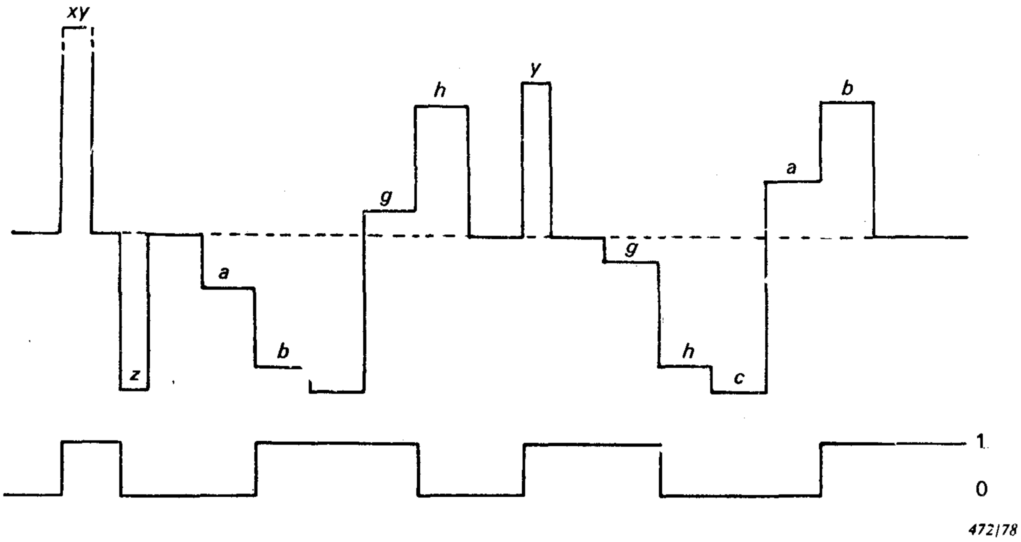


FIG. 4. — Bistable non-polarized relay (not applicable to remanence relays).

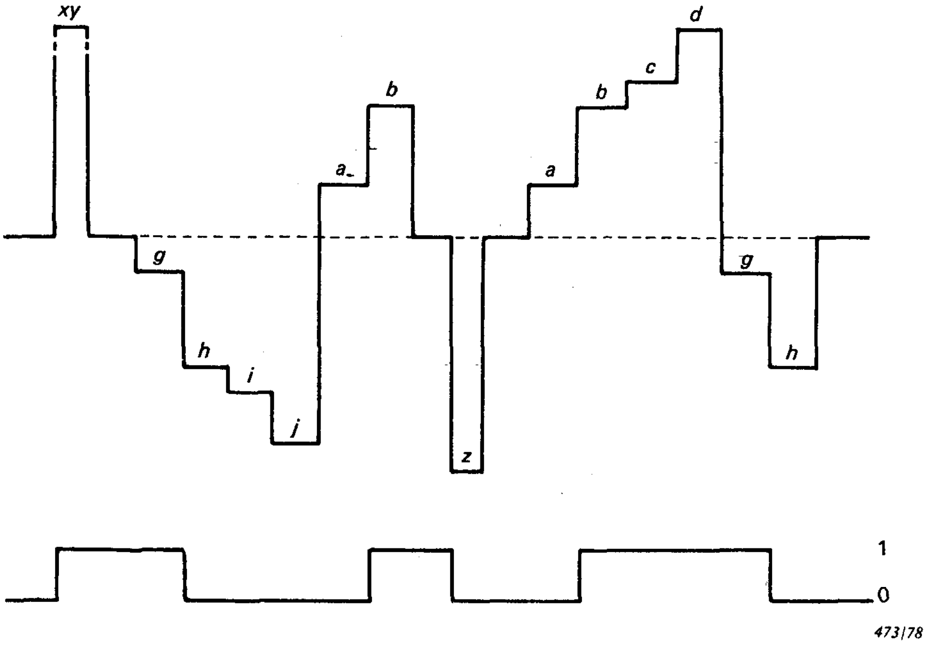


FIG. 5. — Bistable polarized relay (example).

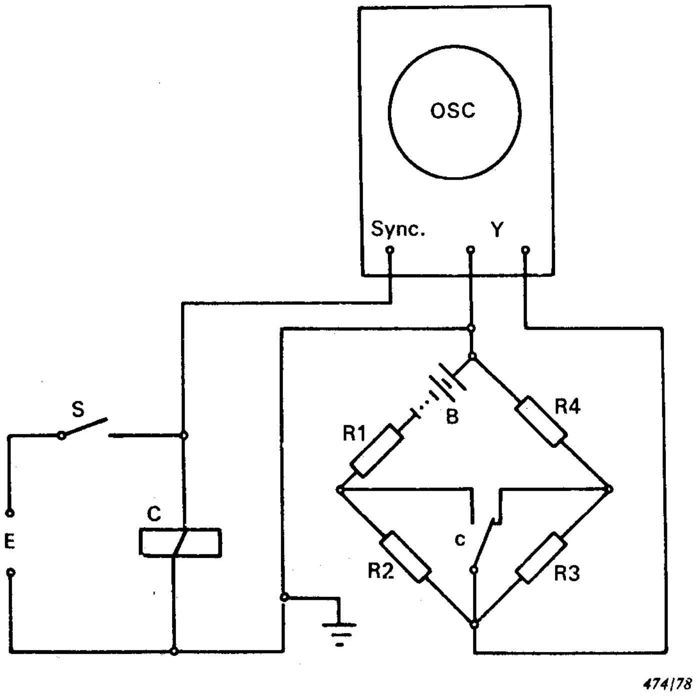


FIG. 6. — Typical circuit for the measurement of time parameters.

C	Coil of the relay
c	Contact of the relay
E	Energization supply
S	Switch, bounce-free
B	Battery
R1 to R4	Resistors
OSC	Oscilloscope
Sync	Trigger input
Y	Vertical deflection input

Note. — In order to distinguish between bridging and transit times it is advisable to take the following values for the resistors:

$R_1 = 1 \quad R_2 = 2 \quad R_3 = 2/3 \quad R_4 = 1$

Reference: Clause 25

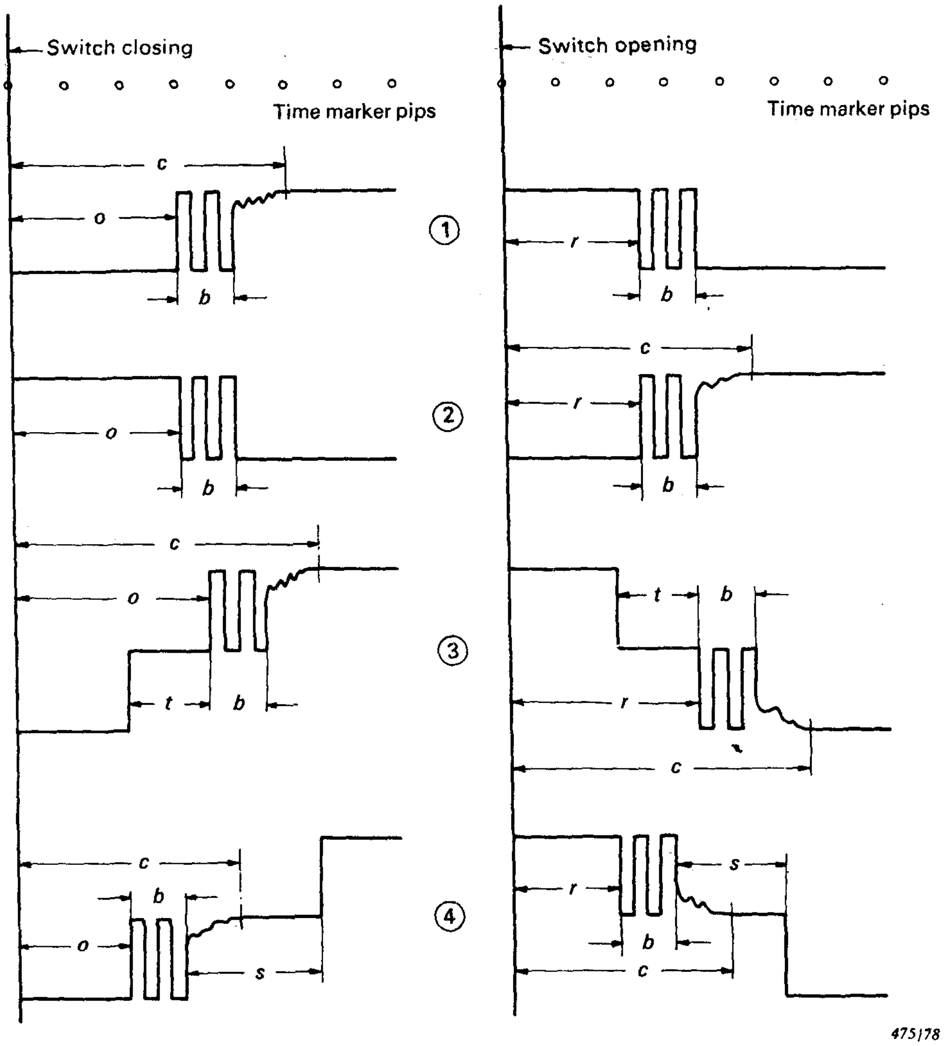
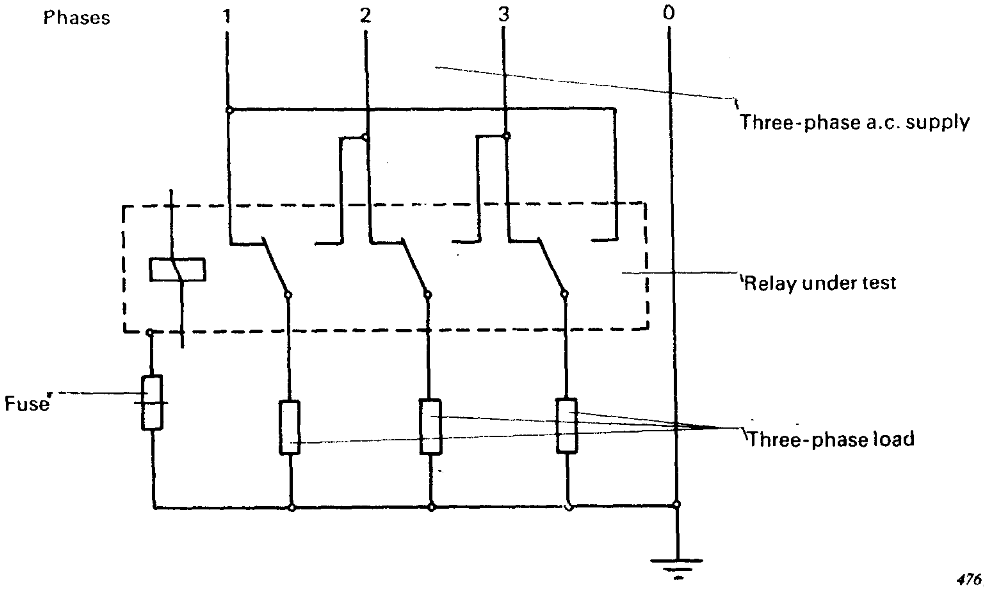


FIG. 7. — Typical traces on an oscilloscope screen during time measurements.

① Make contact
② Break contact
③ Break-before-make contact

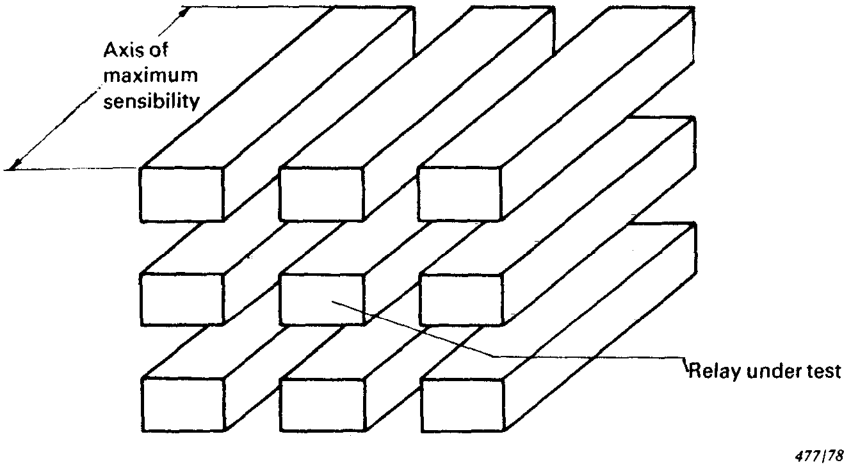
④ Make-before-break contact

o Operate time
r Release time
b Bounce time
t Transfer time
s Bridging time
c Time to stable closing
Reference: Clause 25



Reference: Clause 46

FIG. 8. — Test circuit for load transfer.



Reference: Clause 48

FIG. 9. — Mounting array for adjacent similar relays.